Air Development Center. Permission of this agency to publish the paper is gratefully acknowledged.

Discussion of this paper, if any, will appear in JOURNAL OF METALS, November 1955, and in AIME Metals Branch Transactions, Vol. 203, 1955.

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Technical Note

High Temperature Vacuum Etching on Pure Titanium

by W. D. Bennett

AN interesting effect has been observed in the vacuum etching of titanium in the high temperature β phase. Using a high vacuum annealing furnace, operating at less than 2×10^{-6} mm with a tubular titanium liner, it has been found possible to etch polished metallographic specimens at different temperatures between room temperature and 1000°C without contamination or increase in hardness.¹ Heat etching of titanium has been reported by other workers,² but the following example is of interest as an experiment under high vacuum in the absence of any contamination.

Two polished specimens of iodide-processed titanium are placed at different positions along the axis of the furnace corresponding to temperatures of 900° and 800°C above and below the α - β transus. The specimens are then raised to these temperatures and annealed simultaneously for 3 hr under the same high vacuum conditions. After cooling and withdrawing the specimens, their surfaces are photographed without further treatment. Figs. 1 and 2 show the results for the 800° and 900°C specimens, respectively. Fig. 1, corresponding to a vacuum etch in the α region, shows a typical equiaxed structure

with what appears to be a slight shift of grain boundaries. Fig. 2, corresponding to a vacuum etch in the β region, shows an equiaxed type of structure with the growth of striations in certain grains. The striations are only superficial, as a light polish and chemical etch restores the clean equiaxed structure. The vacuum etch, occurring as it does above the α - β transus, records the state of the metal in the β phase by means of the surface relief produced by the selective evaporation of metal from different grains; the metal itself reverts to the equiaxed α on cooling.

The nature of the " β etch" (Fig. 2) suggests that, in transforming from the close-packed-hexagonal α to the body-centered-cubic β , lenticular-shaped laminae are formed parallel to common planes of the two structures. This would explain why some grains appear to be unaffected by the etch. The technique has interesting possibilities in the investigation of the mechanics of high temperature transformation.

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¹ W. D. Bennett: Vacuum Heat-Treatment. *Metal Industry* (1954) 84, No. 13.

² F. C. Holden, H. R. Ogden, and R. I. Jaffee: Microstructures and Mechanical Properties of Iodide Titanium. *Trans. AIME* (1953) 197, p. 238; JOURNAL OF METALS (February 1953).

Fig. 1—Titanium vacuum etched at 800°C (α etched). X100. Area reduced approximately 35 pct for reproduction.

Fig. 2—Titanium vacuum etched at 900°C (β etched). X100. Area reduced approximately 35 pct for reproduction.